Analytics Across the Enterprise

How IBM Realizes Business Value from Big Data and Analytics

Brenda L. Dietrich · Emily C. Plachy · Maureen F. Norton
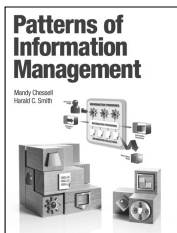
Foreword by Linda S. Sanford
Senior Vice President, Enterprise Transformation, IBM Corporation

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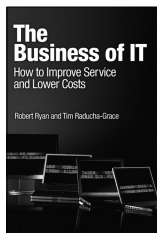
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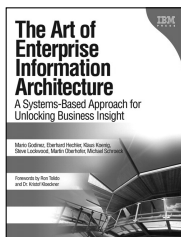
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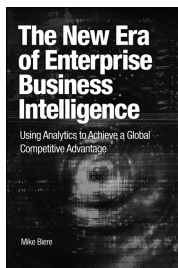
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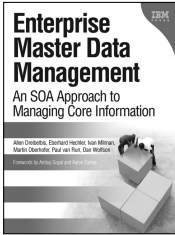
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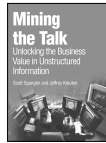
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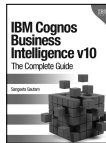Unlocking the Business Value in Unstructured Information
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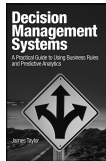
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Praise for *Analytics Across the Enterprise*

"Few major high-tech companies eat their own dog food. But give IBM credit: It practices what it preaches. This book provides an inside look at how IBM has applied analytics to nine business functions, the lessons it has learned, and the value it has derived. This book is valuable for anyone in a large company who wants to know how to apply analytics profitably."

—**Wayne Eckerson**, Principal Consultant, Eckerson Group, and author, *Secrets of Analytical Leaders: Insights from Information Insiders*

"*Analytics Across the Enterprise* shows how even the most complex enterprise can transform itself with analytics. A powerful collection of real-world projects shows that using analytics to improve decisions, especially operational decisions, drives efficiency *and* innovation. The stories in this very readable book show the importance of actually taking action, not just developing insight; of caring about the end user context, not just the model; of gaining buy-in and managing organizational change; and much more. A great guide for anyone transforming their own organization with analytics."

—**James Taylor**, author, *Decision Management Systems: A Practical Guide to Using Business Rules and Predictive Analytics* (IBM Press)

"*Analytics Across the Enterprise* is the only book on analytics written by three world-class experts 'standing on the shoulders of a giant' analytics powerhouse: an impressive first-hand account of nine breakthrough analytic journeys from 70 top executives and practitioners, the largest private math department in the world, and a leading consulting think tank. This is an unprecedented tour de force showing how a best-of-breed analytics company revolutionized its own business model."

—**Gonçalo Pacheco de Almeida**, Associate Professor of Strategy, Head of the Business Analytics Initiative, and Academic Director of the MBA Strategy Specialization, HEC Paris Business School and the French National Scientific Research Center–HEC Lab

"A thoughtfully written collection of stories from within IBM, with proven techniques that are valuable for all current and future business leaders. IBM has been doing analytics since before it was 'cool' and, for the first time, shares an inside look at the very pragmatic, inspiring approach complete with lessons learned. *Analytics Across the Enterprise* not only changes the game, it explains how to win."

—**Lawrence G. Singleton**, PhD, CPA, Dean, School of Management, Professor of Accounting and International Business, Marist College

"Organizations are awash in data. Many have transformed this data into information, yet few have identified patterns of insight from this information. A rare number of organizations can take the insight to action, but even fewer can create a pathway from data to decisions. In *Analytics Across the Enterprise,* Dietrich, Plachy, and Norton definitively chronicle what it takes to apply big data and analytics in the transformation of enterprises. The results: Successful leaders create competitive advantage in smarter workforces, optimized supply chains, and predictable sales performance. Organizations will learn how to move not only from gut-feel intuition but also to powerful fact-based decision making."

—**R "Ray" Wang**, Principal Analyst and Founder, Constellation Research, Inc.

"The growing demand for analytics is a priority for business and IT to collaborate on the processes and technology required to gain the insights to guide organizations to be effective. This book helps organizations gain a perspective on what operating analytics across the enterprise is all about and most importantly why it is crucial across lines of business where the outcomes can be achieved from making continuous investments."

—**Mark Smith**, CEO and Chief Research Officer, Ventana Research

"Glimpses of the IBM vision of the future for analytics have regularly appeared in the literature, and now for the first time we have a comprehensive inside account of how IBM uses advanced analytics to compete globally. Using examples from many functions (HR, marketing, finance, supply chain), this book provides a fascinating view of IBM as an intensively data-driven corporation. Senior executives familiar with analytics and data applications will find many ideas in this book on how they can harness analytics to improve their corporation's performance. Executives less familiar with analytics may experience some 'shock and awe' in reading how far data- and analytics-driven corporations have progressed and what formidable competitors they have become."

—**Peter C. Bell**, Professor, Management Science, Ivey Business School at Western University

"*Analytics Across the Enterprise* is a live chronicle of how the practice of analytics transcends the business functional boundaries and how it benefits all the business functions."

—**Dr. Adam Fadlalla**, Associate Dean for Academic Affairs and Professor of Information Systems, College of Business and Economics, Qatar University

"The use of data and analytics to generate value is a journey for all organizations: a journey of technology, operational self-awareness, and culture. The joy and challenge of data and analytics is that it is difficult, and as such, it is a source of sustainable competitive value. This book tells the story of the journey of adoption of analytics for IBM and how we became a company driven by data and analytics. It explores the technical and mathematical complexities of the journey, the different business use cases, and the value it delivered to our clients, our employees, and our shareholders."

—**Fred Balboni**, Global Managing Partner, Strategy and Analytics, Global Business Services, IBM Corporation

Analytics Across the Enterprise

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Analytics Across the Enterprise

How IBM Realizes Business Value from Big Data and Analytics

Brenda L. Dietrich, Emily C. Plachy, and Maureen F. Norton

For the many pioneers at IBM who are breaking new ground
to realize business value from big data and analytics.

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Foreword

Like many of our clients, IBM® itself is focused on becoming a smarter enterprise. Connected people, integrated processes, and instrumented data: These form the foundation for "smarter." A smarter enterprise makes decisions differently, creates value differently, and delivers value differently…and it all starts with the creative application of analytics.

In my conversations with clients about transformation, they often ask how IBM has approached analytics. Where should we get started? What are you doing inside IBM? What advice would you offer from your experience so far?

To help answer these questions for clients, our analytics practitioners inside IBM collaborated to develop this book. IBM has moved aggressively the past several years to build our analytics capabilities—through hiring talent, developing software, and acquiring firms with analytics tools that enhance our portfolio. IBM itself has been the alpha and beta for the deployment of these new technologies across our operations—from how we manage finance and marketing to how we optimize our supply chain and attract, retain, and develop talent. Indeed, we've found that in virtually every aspect of your organization, you can make smarter, more informed decisions by embedding analytics into how you do business.

I hope you will find our experience relevant and useful as you consider how to best seize on the power of big data, the world's newest natural resource for competitive advantage. Progressive leaders are putting big data to work in fields ranging from finance to farming, from presidential politics to professional sports. It's not just the data; it's the insights gained from analyzing data that give organizations an edge over the competition.

As I tell clients, transformation is hard; it takes ongoing commitment and leadership from the top of the organization. But if there's one truth I've learned about transformation over the years, it's that you should always move

faster than you think you should. That's the only way to stay ahead of today's unrelenting pace of change.

This principle holds true for the adoption of analytics, the centerpiece of the next wave of our transformation. Don't wait for your data to be perfect. The time to start on this journey is now…and we hope our own experience at IBM will help you accelerate the benefits that accrue when you unlock the hidden value and power of your data.

—Linda Sanford
IBM Senior Vice President, Enterprise Transformation

Preface

The genesis for this book came when Doug Dow, Vice President, Business Analytics Transformation, observed that a number of good analytics books were being published, written by experts in analytics, and that IBM had experts with significant experience solving business problems by applying analytics. Dow approached Brenda Dietrich, an IBM Fellow and an eminent operations research and analytics expert. Dietrich was receptive to the idea but was reluctant to sign up to write the book alone. Dow later approached two of his Business Analytics Transformation department members, Emily Plachy and Maureen Norton, who both jumped at the chance to tell IBM's story. Another motivation for the book is that Dow receives frequent requests from clients to learn how IBM is using analytics to elevate business results, so we know that IBM's story is of interest.

As we embarked on the journey to write this book about analytics, we were mindful of the rising tide of materials touting the value of analytics. So what would cause someone to cast his or her net and catch this one? Would a book about the challenges and triumphs, to continue the analogy, of one of the largest global ships on the sea have insights and lessons that others could benefit from, or at least find entertaining enough to read? We decided that this is a story that needed to be told. We decided that C-level executives in Fortune 500 companies, small business owners, and MBA students and faculty would see themselves and their challenges on these pages, and we needed to write this book. Introducing readers to a wide spectrum of ideas about how analytics is much more than a technology and instead is a smarter way of doing business would be reason enough to sail forward.

When we started planning for the book, we decided to organize it by business function. We identified analytics projects within a business function that were realizing value. Next, we interviewed the key members on the

projects. Then, one of the authors volunteered to be the lead writer for that chapter.

We authors made heavy use of IBM Connections, IBM's collaborative software, to interact as we wrote the book, creating a Connections Activity for the book, organized by chapters. During reviews, we added Connections Folders and Files, which helped us keep track of the many reviews and versions of each chapter. With three authors working in different locations, efficient collaboration was essential.

As the writing journey progressed, a common phrase kept coming into our conversations: "All roads lead to the book." The book became a seminal part of our work, feeding and enriching every aspect of our day jobs. We were able to leverage insights from the work to improve insights and results, effect connections between teams that were tackling similar problems, and help other transformation teams tell their stories.

Another very exciting aspect to this book is that we wanted it to be useful to the business leaders of today and tomorrow; reaching students and faculty is a high priority. During the development of the book, two of the authors, Maureen and Emily, developed and taught an innovative three-day pilot workshop at a premier MBA program in Europe, HEC University. Working with Dr. Hammou Messatfa, Technical Leader, European Government Industry, IBM Sales and Distribution, they held a very successful big data and analytics workshop, which led to additional analytic educational initiatives. Just as the book was in the final editing stages, Maureen had the opportunity to teach at a big data and analytics workshop for MBA students in the Middle East as well.

Color Images

PDFs of the color images for this book can be downloaded from the companion website. Go to www.ibmpressbooks.com/title/9780133833034 and click the Downloads tab.

Acknowledgments

The stories in this book, detailing IBM's use of analytics to transform processes and results, could not have been told without the time, talent, and cooperation of many people. Some have been quoted in the chapters or referenced in endnotes, but many more helped along the way. We thank Ross Mauri and Doug Dow, whose enthusiasm and executive support of this project made it possible. We interviewed more than 70 people, including executives and practitioners, and we worked with staff members, communications professionals, editors, and more from the teams. We are very grateful to the people mentioned below for telling us their stories and contributing to this book.

About the Authors

Dr. Brenda L. Dietrich is an IBM Fellow and Vice President. She joined IBM in 1984 and has worked in the area now called analytics for her entire career. Her early work involved applying mathematical models to improve the performance of IBM manufacturing lines. During her career, she has worked with almost every IBM business unit and applied analytics to numerous IBM decision processes. For more than a decade, she led the Mathematical Sciences function in the IBM Research division, where she was responsible for both basic research on computational mathematics and for the development of novel applications of mathematics for both IBM and its clients. In addition to her work within IBM, she has been the president of INFORMS, the world's largest professional society for operations research and management sciences, she is an INFORMS Fellow, and she has received multiple service awards from INFORMS. She has served on the board of trustees of SIAM and on several university advisory boards. She is a member of the National Academy of Engineering. She holds more than a dozen patents, has co-authored numerous publications, and frequently speaks on analytics at conferences. She holds a BS in mathematics from UNC and an MS and PhD in operations research/information engineering from Cornell. Her personal research includes manufacturing scheduling, services resource management, transportation logistics, integer programming, and combinatorial duality. She currently leads the emerging technologies team in the IBM Watson™ group.

Dr. Emily C. Plachy is a Distinguished Engineer in Business Analytics Transformation, responsible for leading an increased use of analytics across IBM. She has integrated data analysis into her work throughout her career. Since joining IBM in 1982, she has held a number of technical leadership roles including CTO, Process, Methods, and Tools in IBM Global Business

Services® (GBS), providing architecture and technology leadership and driving the adoption of consistent methods and tools in GBS, and CTO, Enterprise Integration, GBS, providing architecture and technology leadership. She has also held a variety of roles in IBM, including development, ad tech, research, emerging business opportunities, technical sales, and services. Her technology skills include data integration, enterprise integration, solution architecture, software development, and asset reuse. She has experience in multiple industries, including banking, consumer products, retail, telecommunications, healthcare, and petroleum. She has a BS degree in applied mathematics from Washington University, an MSc degree in computer science from the University of Waterloo, and a DSc degree in computer science from Washington University. In 1992, Emily was elected to the IBM Academy of Technology, a body of approximately 1,000 of IBM's top technical leaders, and she served as its President from 2009 to 2011. She has been a long-term champion of women in technology. She is a member of Women in Technology International, the Society of Women Engineers, and INFORMS. Emily lives in New York with her husband, Tony. She is on Twitter @eplachy and on LinkedIn at http://www.linkedin.com/pub/emily-plachy/3/1bb/777.

Maureen Fitzgerald Norton, MBA, JD, is a Distinguished Market Intelligence Professional and Executive Program Manager in Business Analytics Transformation, responsible for driving the widespread use of analytics across IBM. She pioneered the development of an outcome-focused communications strategy to drive the culture change needed for analytics adoption. Maureen created analytics case studies and innovative learning exercises for teaching analytics. She co-created an innovative analytics workshop and taught MBA students in Europe and the Middle East. In her previous role, Maureen led project teams applying analytics to IBM Smarter Planet® initiatives in public safety, global social services, commerce, and merchandising, specializing in cost/benefit analysis and return on investment of analytic projects. Maureen became the first woman in IBM to earn the designation of Distinguished Market Intelligence Professional for developing innovative approaches to solving business issues and knowledge gaps through analysis. She has held a number of analytic and management roles in IBM. She earned BA and MBA degrees from the University of New Haven and a JD degree from the University of Connecticut School of Law. She is a licensed attorney and did her thesis on the legal implications of artificial intelligence. She lives in Connecticut with her husband, Dr. William Norton, and three children, Erin, Colleen, and William. She is a dual citizen of the United States and Ireland. In addition to *Analytics Across the Enterprise*,

Maureen has published "The Benefits of Social Media Analytics 2013" with the IBM Academy of Technology and "Social Media Analytics: Measuring Value Across Enterprises and Industries" in the *Journal of Management Systems*. Maureen is on Twitter @mfnorton and on LinkedIn at http://www.linkedin.com/in/maureennorton/.

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I

Why Big Data and Analytics?

> *"The most competitive organizations are going to make sense of what they are observing fast enough to do something about it while they are still observing it."*
>
> **—Jeff Jonas, IBM Fellow and Chief Scientist,**
> **Context Computing, IBM Corporation**

This is the story of how an iconic company founded more than a century ago, and once deemed a "dinosaur" that would not be able to survive the 1990s, has learned lesson after lesson about survival and transformation. The use of analytics to bring more science into the business decision process is a key underpinning of this survival and transformation. Now for the first time, the inside story of how analytics is being used across the IBM enterprise is being told. According to Ginni Rometty, Chairman, President, and Chief Executive Officer, IBM Corporation, "Analytics is forming the silver thread through the future of everything we do." What is analytics? In simple terms, *analytics* is any mathematical or scientific method that augments data with the intent of providing new insight. With the nearly 1 trillion connected

objects and devices generating an estimated 2.5 billion gigabytes of new data each day,[1] analytics can help discover insights in the data. That insight creates competitive advantage when used to inform actions and decisions. Data is becoming the world's new natural resource, and learning how to use that resource is a game changer.

This book will help you chart your own course to using analytics as a smarter way of driving outcomes. To get the most value from analytics, start with the strategy you are executing and apply analytics to your most important business problems. If you have thought of analytics as only a technology, this book will change that. Analytics is not just a technology; it is a *way of doing business*. Through the use of analytics, insights from data can be created to augment the gut feelings and intuition that many decisions are based on today. Analytics does not replace human judgment or diminish the creative, innovative spirit but rather informs it with new insights to be weighed in the decision process. Michael Lewis, in his book *Moneyball: The Art of Winning an Unfair Game*, describes how even in baseball, which is rooted in statistics, analytics enabled the Oakland Athletics to assemble a competitive baseball team, despite paying the third-lowest salaries.[2] Analytics for the sake of analytics will not get you far. To drive the most value, analytics should be applied to solving your most important business challenges and deployed widely. Analytics is a means, not an end. It is a way of thinking that leads to fact-based decision making.

"We believe that analytics is no longer an emerging field; today's businesses will thrive only if they master the application of analytics to all forms of data. Whether your office is a scientific lab, a manufacturing company, an emergency room, a government agency, or a professional sports stadium, there is no industry left where an analytics-trained professional cannot make a positive impact," says Brenda Dietrich, IBM Fellow and Vice President, Emerging Technologies, IBM Watson.

The intent of this book is to take some of the mystery out of how an organization can leverage big data and analytics to achieve its goals by giving current and future leaders a front-row seat to see how analytics was leveraged to transform IBM. Many consultants, academicians, and others have written eloquently on the topic of analytics, but the stories from within IBM as told by the people who learned lesson after lesson will give a real-world perspective on what works, what doesn't work, and how you can either start or accelerate your own transformation journey.

Why IBM Started an Enterprise-Wide Journey to Use Analytics

IBM has been using what we now call analytics in manufacturing and product design since the late 1950s and in supply chain operations since the 1980s. A pivotal meeting took place in 2004 between Brenda Dietrich and Linda Sanford, then Vice President of Enterprise Transformation, IBM Corporation, when IBM expanded its use of analytics from physical applications, such as supply chain and manufacturing, to applications, such as sales and finance, that did not have processes with such obvious physical characteristics, and IBM's *enterprise-wide* transformation journey to use analytics was launched.

In 2004, Dietrich led the Mathematical Sciences Department in IBM Research, a group that included a range of computational mathematics disciplines, including statistics, data mining, and operations research. Coincidentally, both Dietrich and Sanford received degrees in operations research, which is the practical application of math to real-world problems and was a precursor to much of what is now called business analytics. Sanford had seen the value of the mathematical methods developed in the Mathematical Sciences Department applied to IBM's supply chain operations.

Sanford's transformation team was looking for opportunities to build more analytics capability into IBM's overall transformation. She knew they had to put measurable successes on the board early to create a sense of credibility for their work. Dietrich and Sanford discussed the IBM sales process and the simple, easily tracked metric annual revenue per IBM seller. The goal was to increase the numerator, to generate top-line growth for the company. They started with a small pilot program, working with sales representatives in the general business group in Canada. That initial pilot was able to use IBM internal data, along with publicly available data, to score sales opportunities. The immediate results were a higher-yield pipeline for the sellers and improved revenue per seller. More importantly, they proved the power of analytics to support growth and transformation.

IBM has been an avid consumer of analytic capabilities for the past decade. Use of analytics has spread from engineering-based processes, such as product design, through logistics processes, such as supply chain operations, to human-centric processes, such as sales and workforce management. Seeing the cultural shift in the receptiveness to the use of analytics has been amazing

to see. When IBM started developing sales analytics tools, many sales leaders were skeptical about the value of such tools, believing that converting an opportunity into a sale was largely a function of the seller's actions and could not be predicted in advance. But over the past decade, there has been a sea change in attitude. Now sales managers are asking for more analytics support so they can take their organizations to the next level of performance.

Big Data and Analytics Demystified

If analytics is any mathematical or scientific method that augments data with the intent of providing new insight, aren't all data queries analytics? No. Analytics is often thought of as answering questions using data, but it involves more than simple data (or database) queries. Analytics involves the use of mathematical or scientific methods to generate insight from the data.

Analytics should be thought of as a progression of capabilities, starting with the well-known methods of business intelligence, and extending through more complex methods involving significant amounts of both mathematical modeling and computation. Reporting is the most widely used analytic capability. Reporting gathers data from multiple sources, such as business automation, and creates standard summarizations of the data. Visualizations are created to bring the data to life and make it easy to interpret. As a generic example, consider store sales data from a retail chain. The data is generated through the point of sale system by reading the product bar codes at checkout. Daily reports might include total store revenue for each store, revenue by department for each region, and national revenue for each stock-keeping unit (SKU). Weekly reports might include the same metrics, as well as comparisons to the previous week and comparisons to the same week in the previous calendar year. Many reporting systems also allow for expanding the summarized data into its component parts. This is particularly useful in understanding changes in the sums. For example, a regional store manager might want to examine the store-level detail that resulted in an increase in revenue from the home entertainment department. She would be interested in knowing whether sales increased at most of the stores in the region, or whether the increase in total sales resulted from a significant sales jump in just a few stores. She might also look at whether the increase could be traced back to just a few SKUs, such as an unusually popular movie or video game. If a likely cause of the sales increase can be identified, she might alert the store managers to monitor inventory of the popular products, reposition the products within a store, or even reallocate inventory of the products across stores in her region.

Descriptive and Predictive Analytics

Reporting, also known as *descriptive analytics*, is focused on reporting what has happened, analyzing contributing data to determine why it happened, and monitoring new data to determine what is happening now. Business intelligence (BI) software provides capabilities for descriptive analytics. BI helps enterprises understand how their organization is operating by giving them a clear picture of the recent past. The deployment of BI software also requires an enterprise to carefully think about its key performance metrics, to understand what it wants to measure and monitor, and to develop some process for exploring potential causes underlying changes in measurements. Sometimes it is obvious what should be measured. Other times it is less obvious, such as when someone discovers a leading indicator of revenue through analysis. Once these capabilities have been mastered, many organizations seek to look forward and get "headlights" on what will happen in the future. They turn to *predictive analytics*, which uses techniques such as statistics and data mining to analyze current and historical information to make predictions about what will happen in the future. Predictive analytics typically produces both a prediction of what will happen and a probability that the prediction will happen.[3]

In many ways, the difference between descriptive analytics and predictive analytics is like the difference between a weather report and a weather forecast. Whereas a report describes what has happened, a forecast tells what is likely to happen and how likely it is to happen. An accurate prediction has greater business value, which is why considerable effort is applied to finding data that contains valuable signals about the future and developing analysis methods that can extract the signal effectively. In the past, performing predictive analytics had a reputation of requiring deep analytic skill. Today, modern tools have broadened the population of users who can leverage predictive analytics to augment decision making. No introduction to predictive analytics is complete without the caution that a prediction can be no better than the data that is used to make it. Thus incorrect data will likely lead to incorrect predictions, and events that have never been observed and captured in the data will never be predicted from analysis of that data.

Predicting what will happen based on the past can be quite useful. It can, for example, help a regional retail manager understand demand for a frozen dessert in the stores he manages as a function of the weather and the local competition. But, more importantly, it can also show him the relationship between past sales of this dessert and promotional pricing, coupons, and advertising. If he assumes that the same relationships will hold going forward, he can then estimate (or predict) future sales that will occur under

different pricing and advertising schedules. Predictive analytics that finds relationships between actions and outcomes is particularly useful.

Prescriptive Analytics

We use the term *prescriptive analytics* to cover analytics methods that recommend actions. In general, the goal is to find a set of actions that is predicted to produce the best possible outcome. To do this, you need to understand the relationship between actions and outcomes. In many cases, that relationship is clear and (more importantly) constant. If producing and distributing a newspaper circular costs 30 cents per copy, then the cost of distributing it to any specified number of customers is clear: 30 cents multiplied by the number of customers. However, the value, in terms of increased revenue, of the circular can only be inferred by looking at past data and, for example, comparing sales in weeks during which no circular was distributed to sales in weeks in which a circular was distributed. But the inferred relationship may be different in different towns, and it may vary by week of the year. That is, the computed value must be recalculated whenever new data becomes available. Despite the limitations, it seems clear that value can be derived through careful and appropriate use of predicted relationships to make decisions. Mathematical optimization has been used for decades to recommend decisions based on known, constant relationships between actions and outcomes. It is used extensively in supply chain and logistics decisions involving scheduling and allocation of resources. More recently, it has been used for decisions where some relationships are predicted from historical data rather than being based on physical limits (for example, transportation time) or business rules (for example, economic order quantities). Examples include setting prices based on predicted price elasticity, advertising based on predicted views of the ad and predicted sales lift per viewer, and targeted promotional offers (for example, coupons at checkout) based on customer segmentation.

Social Media Analytics

Analytics can also be applied to data that does not come from within an enterprise and to data that is not easily interpreted as transactions, such as data from Twitter. Several emerging areas within analytics are already providing business value. One area is *social media analytics*, which analyzes, or "listens," to social media data to assess public opinion, or sentiment, on a variety of topics.[4] Examples of social media include blogs, micro-blogs (such as Twitter), social networking (such as Facebook), and forums. It is possible to

mine social media for comments on a particular subject and analyze them for positive and negative sentiment, how people feel about a topic, or the "pulse" of a community related to a topic. A common way to communicate sentiment is to use a dashboard with views for volume trends over time, sentiment trends over time, and geographic distribution of sentiment. A frequent use of social media is to mine customer data to get feedback on products.[5] Measuring the return on investment (ROI) of using analytics for social media can present a challenge. Value driver trees (that is, visualizations of the hierarchy of influences of different value drivers) have been used to measure the value of using social media analytics for a sports clothing manufacturer, a city government, and an automotive manufacturer, among other industries.[6]

Entity Analytics

Another emerging area is *entity analytics*, which focuses on sorting through data and grouping together data that relates to the same entity. As a simple example of the power of entity analytics, consider three customer records, two of which have no data in common, and a third that has a driver's license number which is the same as that of customer record one as well as a credit card number which is the same as customer record two. These three records can be combined into one record that has more complete data than each of the three individual records. Entity analytics is a powerful technique for recognizing context and detecting like and related entities across large collections of data. Jeff Jonas, IBM Fellow and Chief Scientist, Context Computing, contends that the data enterprises have to deal with is growing so fast that enterprises are developing amnesia; that is, using the same techniques to cleanse and analyze data causes them to get behind because the amount of data is increasing so fast.[7] Jonas uses a puzzle as a metaphor for organizations' need to sort through data to make sense of it and develop context; he says that an ever-growing pile of puzzle pieces represents the ever-growing amount of data, and until you try to assemble the pieces of the puzzle or data, you do not know what you are dealing with.[8] When teaching MBA students about big data and analytics, Maureen Norton and Emily Plachy include an exercise where the students work enthusiastically to put together hundreds of puzzle pieces using multiple tables, shouting out insights as they discover them.

Cognitive Computing

Although entity analytics is helpful in finding relationships between pieces of data and can incorporate new data to either confirm or negate

previously found relationships, additional methods can be applied to garner insight from unstructured data. *Cognitive computing*, computing systems that interact with people in new ways to provide insight and advice, is emerging just when we need it to help us uncover insight from the explosion of big data. Chapter 11, "Reflections and a Look to the Future," describes this exciting new era of computing.

Big Data

The most easily available source of data for analytics is an enterprise's own internal transaction data. For our retail example, this includes inventory data, sales data, employee data, and promotion and advertising data. Increasingly, enterprises are augmenting their internal data with data from external sources, including social media data. Whereas enterprise transaction data tells the retailer what has been bought, social media data can give the retailer early insight into what customers intend to buy. With the adoption of social media tools such as Twitter and the growth of blogs and forums on the Internet, the amount of social media data is growing very large, and analyzing it is providing significant insights and benefits to businesses.

Big data has four dimensions, known as the four *V*s:[9]

- **Volume:** The size of data, which can range from terabytes to petabytes of data
- **Variety:** The forms of data—structured, text, multimedia
- **Velocity:** The speed at which data is available and analysis of streaming data
- **Veracity:** Data quality—managing the reliability of data

Consumers who are active in the big data social media world are driving enterprises to create collaborative systems, known as *systems of engagement*.[10] These new systems have led to the creation of engagement analytics to measure the value of engagement.[11] Engagement analytics can be used to measure employee engagement and customer engagement. Systems of engagement and engagement analytics are covered in more detail in Chapter 5, "Enabling Analytics Through Information Technology."

This book shows how IBM has solved a wide variety of business problems by leveraging analytics to elevate business results. The types of analytics described include predictive analytics, prescriptive analytics, social media analytics, and entity analytics. Some of the analytics is performed on big data. The use of analytics not only drives cost savings and revenue growth

but also provides more accurate and timely information to improve decision making and reduce complexity, which helps better manage the business. Analytics gives you the ability to anticipate, and that's very powerful. So what does this mean for you? Whether you are in business for yourself or within a large company or a nonprofit or a government entity or a classroom preparing for your future, knowledge of the possibilities that analytics opens up will give you a competitive advantage. Understanding the journey that IBM has taken will shine a light on where you can get value from big data and analytics and illuminate your path to success in business.

Why Analytics Matters

"People respond to facts. Rational people will make rational decisions if you present them with the right data."

–Linda Sanford, Senior Vice President, Enterprise Transformation, IBM Corporation

Quite simply, analytics matters because it works. You can be overwhelmed with data and the value of it may be unattainable until you apply analytics to create the insights. Human brains were not built to process the amounts of data that are today being generated through social media, sensors, and more. While gut instinct is often the basis for decisions, *analytically informed intuition* is what wins going forward.

Several studies have highlighted the value of analytics. Companies that use predictive analytics are outperforming those that do not by a factor of five.[12] In a 2012 joint survey by the IBM Institute of Business Value and the Said Business School at the University of Oxford of more than 1,000 professionals around the world, 63% of respondents reported that the use of information (including big data and analytics) is creating a competitive advantage for their organizations.[13] IBM depends on analytics to meet its business objectives and provide shareholder value. The bottom line is that analytics helps the bottom line. Your competition will not be waiting to take advantage of the new insights from big data. Should you?

IBM has approached the use of analytics with a spirit of innovation and a belief that analytics will illuminate insights in data that can help improve outcomes. The company hasn't been afraid to make mistakes or redesign programs that haven't worked as planned. Unlike traditional IT projects, most

analytics projects are exploratory. For example, the Development Expense Baseline Project explored innovative ways to determine development expense at a detailed level, thereby addressing a problem that many thought was impossible to solve. IBM analytic teams haven't waited for perfect data to get started; rather, they have refined and improved their data along the way. For example, the Coverage Optimization with Profitability project team described in Chapter 9, "Increasing Sales Performance," knew it had incomplete data, but rather than wait for the various data stewards to improve their data, the team jumped in and made progress incrementally on data governance and data cleansing. Using this approach will reduce your time to value. Using this approach will reduce your time to value. The key is to put a stake in the ground with a commitment that analytics will be woven into your strategy. That's how IBM does it. This approach is also effective with big data. Rather than postpone the leveraging of big data, you should embrace it, establish a link between your business priorities and your information agenda, and apply analytics to become a smarter enterprise.

Governance

A majority of clients who have engaged with IBM to learn about the internal transformation efforts are most interested in the governance topic. How do you organize to take advantage of analytics? Where do you put the analytics group? Is it an IT function? Who leads analytics projects, and who is on the team? How do you set up your organization to be able to adapt processes to incorporate analytics? Interestingly, it is organizational obstacles—not data or financial concerns—that are roadblocks to adoption of big data and analytics; examples include not knowing how to use analytics to improve the performance of the enterprise and lack of bandwidth because of competing priorities.[14]

IBM's approach has been very pragmatic and initially was quite focused in areas of the business that had the most challenges. Analytics was used as a means to address the most significant challenges first. There was a general notion that analytics could add value within IBM, but where it got very specific very fast was with large, critical problems in supply chain operations. At one point, supply chain problems were costing IBM millions of dollars per year. That story changed dramatically when using analytics become a way of doing business, and today IBM's supply chain is world class.

IBM's transformation to use analytics is part of a larger enterprise transformation that began in 1993 to transform its business processes. As part of this

enterprise transformation, IBM's organization evolved to incorporate *Value Services*, defined as a group of functional units, processes, and initiatives dedicated to working collaboratively to improve productivity and effectiveness through business transformation:[15]

1. *Globally Integrated Enterprise Shared Services:* To support this transformation, globally integrated organizational units providing support services to all of IBM were formed.[16] Four of the functional areas described in the upcoming chapters are Globally Integrated Enterprise Shared Services: human resources, integrated supply chain finance, information technology, and marketing.

2. *Enterprise Transformation Initiatives:* A number of enterprise-wide initiatives were launched to drive radical, innovative transformation in the way IBM works with clients, business partners, and its own employees. Three Enterprise Transformation Initiatives, which are described in later chapters, are Development, Smarter Commerce™ Inside IBM, and Hardware Product Management Transformation.

Since they provide support services to all of IBM or drive radical, innovative transformation, Globally Integrated Enterprise Shared Services and Enterprise Transformation Initiatives are control points for leveraging analytics. For example, when Finance creates and deploys an analytic solution to predict spending, all of IBM's business units reap the benefits.

The next evolution of IBM's transformation is to migrate from a globally integrated enterprise to a smarter enterprise by optimizing the entire enterprise with the following technologies:[17]

- **Analytics** to gain business insight for customers and the enterprise
- **Social media** for business collaboration both inside and outside the enterprise
- **Mobile communications** for pervasive connectivity
- **Cloud technologies** for IT enablement

IBM's transformation to a smarter enterprise is described in "Creating a Smarter Enterprise: The Science of Transformation."[18] IBM's transformation to use analytics enterprise-wide, which began in 2004, continues; today, analytics is complemented with social, mobile, and cloud.

Many people are surprised to learn that at IBM, analytics was *not* centralized and *not* driven out of IT. Analytics is mostly thought of as a technology,

and many expect technology projects to be owned by IT, but because analytics is a way of doing business, it needed to be close to the business, woven like a silver thread into the fabric of all of the business processes. The focus was on how to become smarter and more agile with the use of analytics to solve business problems; being close to those problems was required. Business analysts partner with analytics practitioners and in some cases used what IBM refers to as the "secret sauce" for analytics—IBM Research, which is a unique and differentiating function. Few companies have a 400-person math department to draw on. What does this mean for other companies? IBM has leveraged its math department both to apply analytics internally and to add some of the learnings and benefits to its analytics products and solutions. So you can get the benefit of a large math department without having to have your own.

Proven Approaches

Staying focused on solving business problems was the pragmatic start, and the other crucial element was having very high-level executive support from the beginning. From a governance perspective, those are two key levers to drive value: focus on actions and decisions that will generate value and have high-level executive sponsorship.

The ideal team to do analytics is a collaboration between an experienced data scientist,[19] a person steeped in the area of the business where the challenge needs to be solved, and an IT person with expertise in the data in that particular area of the business.

A joint study by MIT Sloan and the IBM Institute for Business Value developed several recommendations.[20] The first is that you start with your biggest and highest-value business challenge. The next recommendation is to ask a lot of questions about that challenge in order to understand what's going on or what could be going on. Then you go out and look for what data you might have that's relevant to that challenge. Finally, you determine which analytic technique can be used to analyze the data and solve the problem.

Because most companies have constraints on the amount of money and skills available for projects, estimating the ROI can provide a better differentiator for selecting the project with the highest potential impact than relying on instincts. Estimating an analytics project's ROI involves both capturing the project costs and measuring the value. As mentioned earlier in this chapter, value driver trees are an effective technique for measuring value.[21]

Analytics changes the way you approach your business and becomes an integral part of the way you manage and transform your business.

Gauging Progress

Once you've started solving business problems using big data and analytics, how do you know if your capabilities are progressing? IBM developed the Analytics Quotient (AQ) so that organizations can measure their maturity in adopting big data and analytics and set goals for enhanced adoption.[22] Based on answers to approximately 15 questions, organizations can find out if they are novices, builders, leaders, or masters.

In 2013, the IBM Institute of Business Value published results from a study focused on how to convert insights from big data and analytics into results.[23] More than 900 business and IT executives were surveyed, and through research, nine levers were identified that distinguish leaders who are able to realize value from big data and analytics from those who are not. As described in the report, the nine levers are:[24]

- **Source of Value:** Decisions that generate value
- **Measurement:** Business outcome measurement
- **Platform:** Integrated hardware and software capabilities
- **Culture:** The availability and use of data and analytics within an organization
- **Data:** Formal processes for data governance and security
- **Trust:** Confidence within the organization
- **Sponsorship:** Support and involvement of executives
- **Funding:** A rigorous analytics funding process
- **Expertise:** Development of and access to data and analytics skills

The authors found a strong link between organizations that excel in these nine levers and organizations that are deriving the greatest value from data and analytics. Further, they found that the levers do not impact the creation of value in the same way, and they identified a progression of three steps—*Enable*, *Drive*, and *Amplify*—each with three of the levers (see Figure 1-1):[25]

- *Enable* forms the foundation for creating value from big data and analytics. The foundation is actions and decisions that generate value, measuring outcomes and providing a platform for big data and analytics activities.

- *Drive* has the actions needed to create value by moving from analytics discovery to value creation, which is aided by having an analytics and big data culture, having data governance and data security, and creating trust.
- *Amplify* increases the amount of value realized by providing momentum to translate insights into actions that increase an organization's bottom line. This is done through sharing a common vision, managing and monitoring analytic investments, and knowledge-sharing opportunities.

Enable			
Basis for Big Data and Analytics	**Source of Value**	**Measurement**	**Platform**
	Actions and Decisions That Generate Value	Evaluating Impact on Business Outcomes	Integrated Capabilities Delivered by Hardware and Software
Drive			
Needed to Realize Value	**Culture**	**Data**	**Trust**
	Availability and Use of Data and Analytics	Data Management Practices	Organizational Confidence
Amplify			
Boosts Value Creation	**Sponsorship**	**Funding**	**Expertise**
	Executive Support and Involvement	Financial Rigor in Analytics Funding Process	Development and Access to Skills and Capabilities

Source: "Analytics: A blueprint for value—Converting big data and analytics into results," IBM Institute for Business Value. © 2013 IBM Corporation

Figure 1-1   Nine levers: Capabilities that enable and enhance big data and analytics development, delivery, and value creation

As you start your journey to leverage big data and analytics for business value, start by leveraging the three levers in *Enable—Source of Value*, *Measurement*, and *Platform*—and then move to *Drive* and then finally to *Amplify*.

Overview of Nine Journeys

IBM has many business functions. Some of them are generic functions—including human resources, finance, supply chain, sales, information technology, marketing, and services—that can be found in most enterprises.

Other functions—such as software development and hardware manufacturing—are more specific to a technology company, although analogous functions exist in other industries (for example, manufacturing cars in the automotive industry).

This book contains 31 case studies of how nine business functions have incorporated analytics to change the way they do business and to improve their business results. Each business unit's story is told as a separate chapter, beginning with an overview of the unit's journey to improve its business results by levering analytics, including the pitfalls and lessons learned, followed by a more detailed description of one or more significant analytics projects within that business unit. The nine business functions started their analytics journey at different times, and they're now at different stages; they also used different approaches. Each journey is different, though we do see some common themes.

Some business units have been on long journeys, others are just starting their journeys, and others are in between. All of the business units have a history of using descriptive analytics or business intelligence. This book concentrates on predictive and prescriptive analytics and newer forms of analytics, such as social media analytics and entity analytics.

IBM's supply chain organization started its journey the earliest and has numerous analytics solutions. You will learn how the supply chain organization is using analytics to reduce expenses and to predict quality problems before there is an impact. The supply chain organization is also using social media analytics to predict supply disruptions based on events around the world. The finance organization also has a rich history of using analytics. Examples include using analytics to reduce financial risk and to reduce the risk of an acquisition failing to meet objectives. IBM's human resources (HR) organization started using analytics more recently and is using predictive analytics to proactively address retention and is using social analytics, big data, and sentiment analysis to take the "pulse" of what employees are thinking about various issues, such as a new HR program. IBM's information technology (IT) organization has developed a number of applications that leverage analytics and big data, such as how to find an employee and how to answer questions about products and services from the sales force.

Emerging Themes

You will notice some common themes in the nine IBM journeys described in this book.

Relationships inferred from data today may not be present in data collected tomorrow. The relationships that you infer from data about the past do not necessarily hold in data that you collect tomorrow. You cannot analyze data once and then make decisions forever based on old analysis. It's important to continually analyze data to verify that previously detected relationships are still valid and to discover new ones. Fortunately, major discontinuities with data do not happen very often, so change generally happens gradually. Social media sentiment, however, has a much shorter half-life than most data. Using relationships derived from past data has been repeatedly demonstrated to work better than assuming that no relationships exist. The relationships that have been detected are likely correlation rather than causality. However, these relationships, if detected and acted upon quickly, may provide at least a temporary business advantage.

You don't have to understand analytics technology to derive value from it. For a long time, many business leaders expressed the opinion that mathematics should be used by only those who understood the details of the computations. However, in recent years this view has been changing, and analytics is being treated like other technologies. You must learn how to use it effectively, but it is not necessary to understand the inner workings in order to apply analytics to business decisions. You have to apply analytics methods in the context of the problem that is being solved and make the results accessible to the end user. But just as the user of a car navigation system does not need to understand the details of the routing algorithm, the end user of analytics does not have to understand the details of the math. Typically, making the results accessible to the end user involves wrapping the math in the language and the process of the end user. Also, the analytics can be embedded deep inside things so that the user does not see it, like in supply chain operations. Analytics should be usable by anyone, not just those with PhDs in statistics or operations research. Some users will want to understand the algorithms and inner workings of an analytics model in order to trust the results prior to adoption, but they are the exception. Chapter 4, "Anticipating the Financial Future," illustrates such a case.

Fast, cheap processors and cheap storage make analysis on big data possible. Moore's law has resulted in vast increases in computing power and vast decreases in the cost of storing and accessing data. With readily available and inexpensive computing, we can do what-if calculations often and test a number of variables in big data for correlation.

Doing things fast is almost always better than doing things perfectly. Often inexact but fast approaches produce enormous gains because they result in better choices than humans would have made without the use of analytics. Over

time, the approximate analytics methods can be refined and improved to achieve additional gains. However, for many business processes, there is eventually a point of diminishing returns: The calculations may become more detailed and precise, but the end results are no more accurate or valuable.

Using analytics leads to better auditability and accountability. With the use of analytics, the decision-making process becomes more structured and repeatable, and a decision becomes less dependent on the individual making the decision. When you change which people are in various positions, things still happen in the same way. You can often go back and find out what analysis was used and why a decision was made.

How to Use This Book

We have organized this book so you can choose your best path for navigating the content. The next nine chapters describe how IBM has applied analytics to address challenges in nine different business functions. Some may choose to read the chapters sequentially. Others can instead start with the chapters that are of the most interest to them.

This book can also be used as a reference. The appendix includes a table of the 31 case studies described in this book, including the challenges and outcomes, along with the type of data and analytics techniques used to achieve the outcomes. Using the table, you can map from a particular analytics technique to a business challenge and then map to a chapter and page that describes the challenge. For example, if social media analytics is of interest, the table shows that Chapter 2, "Creating a Smarter Workforce," describes how IBM's HR organization uses social media analytics to gain an accurate view of what employees are thinking and that Chapter 3, "Optimizing the Supply Chain," describes how the supply chain organization uses social media analytics to predict disruptions in the supply chain. You can also examine the table to see if the business challenge you are facing is similar to one in the table.

Analytics Across the Enterprise can be used as a text for or a complement to the textbooks for MBA or undergraduate classes with analytics content as it provides real-world examples of using analytics to transform business areas and improve results. We chose nine as the number of business area stories to include so that these nine chapters, along with this chapter and Chapter 11 would fit into a semester-long course.

This book describes how nine different organizations are using analytics as a way of doing business and how they are realizing business value from data and analytics. Throughout this book, you will learn about the business problems selected, the pitfalls encountered, the business value that can be

obtained by using big data and analytics, and the many lessons the teams learned along the way.

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